ICESat-2 Cal/Val 2022 L2 CHIR NIR Lidar Arctic Sea Ice Heights, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Saylam, K., Averett, A., Andrews, J., Kurtz, N. T., & Tilling, R. L. (2026). ICESat-2 Cal/Val 2022 L2 CHIR NIR Lidar Arctic Sea Ice Heights (IS2CV22L2H, Version 1). [Data set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/B0EV8BIL17U2 [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Summary

This data set provides Arctic summer sea ice heights acquired using the Leica Chiroptera 4X (CHIR) airborne lidar system. The near-infrared (NIR) lidar data were acquired during a July 2022 calibration/validation airborne campaign to evaluate the positional accuracies of NASA's ICESat-2 ATLAS measurements.

1.2 File Information

1.2.1 Format

The NIR lidar data are formatted as compressed lidar point data records, version 1.2 (`.laz`).

NOTE: The `.laz` files must be converted to `.las` to display in ArcGIS Pro.

1.2.2 File Contents

The files contain the attributes described in Table 1.

Table 1. File Attributes

Attribute	Description
X	x position (m)
Y	y position (m)
Z	z position (m)
Intensity	The return strength of the laser pulse that generated the lidar point
ReturnNumber	An emitted laser pulse can have up to five returns
NumberOfReturns	The total number of returns for a given pulse
ScanDirectionFlag	The direction the laser scanning mirror was traveling at the time of the output laser pulse. A value of 1 is a positive scan direction, and a value of 0 is a negative scan direction.
ScanAngleRank	Scanning was performed in an elliptic pattern (17 degrees forward and backward, and 20 degrees left and right). At 0 degrees, the laser pulse is directly below the aircraft at nadir. At -20 degrees, the laser pulse is to the left side of the aircraft, while at +20, the laser pulse is to the right side of the aircraft in the direction of flight.
PointSourceId	The flight line from which the point was collected
GpsTime	The GPS time stamp at which the laser point was emitted from the aircraft

WARNING: The `Classification` attribute is assigned “9” (water) in the files but should be ignored.

1.2.3 Naming Convention

1.2.3.1 Lidar

The files utilize the following naming convention:

`IS2CV22L2H_TD_[UTM##]_[RGT###]_[code]_[FL#]_[SSS]_[YYYYMMDD]_01.laz`

Examples:

`IS2CV22L2H_TD_UTM16_RGT531_QD064_FL1_SA_20220726_01.laz`

`IS2CV22L2H_TD_UTM23_RGT453_LB000_FL0_SC_20220721_01.laz`

Table 2. File Naming Convention Variables and Descriptions

Variable	Description
IS2CV22L2H	ICESat-2 Cal/Val 2022 L2 CHIR NIR Lidar Arctic Sea Ice Heights
TD	Topographic lidar (indicates near-infrared data)
UTM##	Projection (UTM Zone 16N, UTM Zone 19N, or UTM Zone 23N)
RGT###	ICESat-2 reference ground track
code	“Cal” = calibration, “IS” = ice sheet; “LB” and “QD” refer to nodes (kml files)
FL#	Flight line number (e.g., FL1)
SSS	Section number (SA, SA1, SA2, SB, SB1, SB2, SC, SD, SE, SF, SG, or SH)
YYYYMMDD	Year, month, and day of data acquisition
01	Data set version 1

1.3 Spatial Information

1.3.1 Coverage

Westernmost longitude: 81.9° W

Easternmost longitude: 41.9° W

Northernmost latitude: 86.1° N

Southernmost latitude: 76.3° N

1.3.2 Ground Resolution

< 0.05 m

1.3.3 Geolocation

NAD83 / UTM Zone 16N (EPSG 26916)

NAD83 / UTM Zone 19N (EPSG 26919)

NAD83 / UTM Zone 23N (EPSG 26923)

1.4 Temporal Information

1.4.1 Coverage

The campaign consists of four flight days:

19 July 2022, 21 July 2022, 23 July 2022 and 26 July 2022

1.4.2 Resolution

Varies

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Measuring ocean surface elevations, sea ice topography and freeboard, and characterizing summer sea ice melt ponds with varying depths has proven challenging when using laser altimeters that operate solely in the NIR wavelength. CHIR uses a NIR (1,064 nm) wavelength for topographic measurements and a green wavelength (515 nm) for bathymetry. Both wavelengths measure target surfaces simultaneously, and scanners emit laser pulses in an elliptic pattern (Palmer scanner).

2.2 Acquisition

An airborne lidar data acquisition campaign was conducted in July 2022, based out of Pituffik Space Base, by the University of Texas at Austin, NASA, and other academic and federal institutions. CHIR was mounted on a Gulfstream V aircraft with a glass viewport, alongside NASA's Land, Vegetation, and Ice Sensor (LVIS). The calibration and validation campaign provided airborne lidar and high-resolution four-band aerial imagery for evaluating retrievals of Arctic summer sea ice heights and melt pond characteristics measured by ATLAS/ICESat-2. Not all prospective flights were executed because of environmental challenges, and a total of four survey flights were completed using CHIR. The data from these four flights (flight path data, lidar, and imagery) will be published separately.

Discrete NIR pulses reflect from hard surfaces and indicate water surfaces, while continuous green-wavelength enters the water column. Depths are determined by computing the time difference between the waveform peaks, where the waveform indicates the travel time of beams that reflect from the surface and bottom of the water column. Each lidar return is tagged with seven fundamental parameters: time, latitude, longitude, ellipsoidal height, and aircraft roll, pitch, and yaw.

The sampling point density of the NIR data is ~1 point/m^2. The green-wavelength sensor generated ~0.4 point/m^2. The CHIR data swath width is approximately two-thirds of the flight altitude (~380 m) and data segments are approximately 3 km in length.

2.3 Processing

The CHIR swath is adjusted to offset the time delay for optimal comparisons with ATLAS/ICESat-2.

The *LidarShift* algorithm aligned the CHIR data swath closer to the ATLAS beam measurements by computing the time difference and modifying each lidar point location to compensate for sea ice drift. Analysis using the Copernicus neXtSIM model provided estimated drift speed to input to the algorithm.

For more details on data alignment and quality, see Saylam et al. (2025).

2.4 Quality, Errors, and Limitations

CHIR system calibration was confirmed using precise multi-channel GNSS survey measurements. The absolute mean height difference was less than 1 cm for both scanning channels. A comparison to ATL03 strong beam photon heights registered on the same surface indicated an absolute mean height difference of less than 1 cm.

CHIR and LVIS measured sea ice heights concurrently at lower altitudes with similar results, confirming the cross-check calibration. The evaluation generated $R^2 > 0.98$ correspondence and Root Mean Square Error of 0.045 m.

The CHIR NIR and ATL07 sea ice surface heights were confirmed to 0.015 m.

Please refer to Saylam et al. (2025) for detailed evaluation results.

3 VERSION HISTORY

Table 3. Version History Summary

Version	Date	Description of Changes
1.0	May 2026	Initial release

4 ACKNOWLEDGMENTS

- Tom Neumann, Lori Magruder, Michelle Hofton, David Rabine, Marco Bagnardi, Sinead Farrell, Helen Cornejo
- CHIR leased/provided by Leica Geosystems of Switzerland
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- Mission critical information provided by NASA
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5 REFERENCES

Saylam, K., Averett, A. R., Andrews, J. R., Short, S. R., Kurtz, N. T., & Tilling, R. L. (2025). Airborne Lidar to Verify ICESat-2 Arctic Summer Sea Ice Heights and Melt Pond Depths: Calibration and Validation Campaign, Greenland 2022. *Earth and Space Science*, 12. https://doi.org/10.1029/2024EA004100

6 DOCUMENT INFORMATION

6.1 Publication Date

May 2026

6.2 Date Last Updated

May 2026